CLAIMS

WHAT IS CLAIMED IS:

1. A method for designing multi-resolution waveforms and filters in the Fourier domain with a property which provides a single waveform design for all of the waveforms at multiple scales and multiple frequencies, the method and property comprising:

> using a subset of the Fourier harmonics as the design coordinates;

> combining the filter design requirements with Wavelet requirements to generate a finite impulse response filter; and

> using the filter design harmonics and frequency translation for the design of waveforms at multiple scales and multiple frequencies.

2. The method of claim 1 further comprising:

> providing filtering least-squares error metrics;

> providing Wavelet orthogonality in-band and adjacent-band least-squares error metrics;

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providing Wavelet quadrature mirror filtering least-squares error metrics;

designing the filters using Fourier domain harmonic design coordinates to minimize the weighted sum of these least-squares error metrics subject to application constraints; and

using the design coordinates for all Wavelets at multiple scales and frequencies

3. The method of claim 1 further comprising:

designing the mother Wavelet in the Fourier domain;

designing the mother Wavelet to meet filtering performance requirements, Wavelet requirements, and application constraints; and

generating the multi-scale Wavelets using the design harmonics and frequency translations.

4. The method of claim 3 for all filtering and waveform applications including

communications performance with no excess bandwidth,

Wavelet analytical and iterated filter bank construction techniques using scaling functions,

decimation and reconstruction for analysis and design filters, and

polyphase filters, linear and non-linear communications,
filters and waveforms, and for synthetic aperture radar and
real aperture radar waveforms.

5. The method of claim 4 for tiling of filtering and waveform
spaces including

      t-f space for communications,

      spatial-f space for media processing,

      feature-f space for pattern recognition,

      t-f-beam space for satellite and cellular
      communications, and the

      time-wavelength space for laser and optical
      communoications.

6. A method for the design of complex Wavelets for placement
within the frequency space with dilation and translation
parameters, using a common set of design harmonics which provide
the Wavelets with multi-resolution capabilities to support
polyphase filter banks, analysis and synthesis filter banks,
ideal decimination and perfect reconstruction, communication
bandwidth on demand, and to support all linear and non-linear
applications of filters and waveforms.